A THESIS

FOR THE DEGREE

OF

DOCTOR OF MEDICINE.

INTRACRANIAL TRIFACIAL NEURECTOMY AND REMOVAL OF THE GASSERIAN GANGLION.

BY

WILFRED ERNEST GIBBONS M.B.C.M. 1896.

INTRACRANIAL TRIFACIAL NEURECTOMY AND REMOVAL OF THE GASSERIAN GANGLION.

Part I.

Preliminary and historical.

It may truly be said that the treatment of trifacial neuralgia, so unsatisfactory in result, has hitherto baffled the resources of our art. Drugs have proved of but little use and then only in the milder degrees of the affection.

That severe form which has earned for itself the name of 'tic douloureux' has long sought relief at the hands of the surgeon, but that relief when found has too often been of short duration.

Morphia has remained, but that too may fail - and worse than fail. Taken in rapidly increasing doses it gradually exerts its demoralizing effects on the central nervous system. Self control becomes weakened, in time the drug loses its power as an anodyne, and the patient is left less able to bear his agony - in a more

desperate plight than before. In the worst cases the attack may occur many times an hour and in those in which hyperaesthetic spots are present in the mouth, the taking of food induces a spasm of agony and even starvation may threaten. There is yet another danger. The wretched sufferer worn out by persistent pain, his control perhaps weakened by morphia, has not infrequently been driven to attempt his own self destruction, thus to put an end to his misery.

There is little cause for wonder that the history of the treatment of so distressing a complaint shows the adoption of surgical measures of successively increasing severity. Neurotomy or division proved to be of ephemeral benefit, only; indeed it was sometimes followed by return of pain of greater intensity owing to the involvement of the reunited ends of the nerve in cicatricial tissue.

Resection of a small portion gave better results, but the relief obtained was merely temporary - Nerve stretching is tried with occasional success in milder cases. The more complete the removal of the affected branches the longer has been the period of immunity. The method of Thiersch, who twists and pulls away considerable

portions of nerve branches was an advance. The more extensive extracranial operations for example those divised by Carnochan, Krönlein, and Rose, result in a fair proportion of cures. These operators attacked the nerve trunks near their foramina of exit from the skull.

There yet remain a large number of cases incurable by these methods.

It may be observed from the foregoing that the history of the surgical treatment of trifacial neuralgia is one of operations at first peripheral becoming more central. Only within very recent years did anyone venture to suggest an attack on the root of the disease within the skull. With the better understanding of the principles implied in the terms antiseptic and aseptic surgery, and with the consequent rapid advance in procedure and technique based on those principles, a measure, which but a very few years ago would have been regarded as an impossibility has now become an accomplished fact.

The first deliberate proposal to remove the Gasserian ganglion, which is recorded, is that of Dr. J. E. Mears of Philadelphia, in 1884. It was however not until six years later that the first attempt to remove the ganglion from the

living subject was made. To Rose of London is due the credit, although Andrews of Chicago had for some months been working up the details of a similar operation.

Rose's first operation for removal of the ganglion was performed on April 2nd 1890. It differed in some important respects from his subsequent operations and would merit record, if for no other reason, for its exceptional severity. The superior maxilla was removed 'by the usual method', 'firstly on account of the extensive disease which probably existed, in the nerves contained in it; secondly, the increased facility this gives for opening the base of the skull and thirdly' - it is interesting to note - 'in deference to the express desire of the patient that, whatever else was done, the side of the jaw where the pain was greatest should be removed'. To obtain an entry into the skull, the blunted pin of a trephine was placed in the foramen ovale and a disc of bone removed. The ganglion was loosened from its bed by means of an aneurism needle and removed in three or four pieces 'by the aid of a narrow probe pointed bistoury and fine hooked forceps, the dura being uninjured'. The patient, a woman, aged 60, suffered severely from shock, but made a good recovery. The eye was lost from

corneal ulceration; for this loss however the cure of the pain more than compensated her.

It is not proposed in this essay to enter into a description of the details of the method subsequently employed by and named after Rose, since it has already become classical and bids fair to become obsolete. Suffice it to say the route taken is through the pterygoid fossa after resection of the zygoma, removal of the coronoid process of the lower jaw with its attached tendon and of the structures occupying the fossa. The dental and lingual nerves are found and used as guides to the foramen ovale. A trephine is applied to the under surface

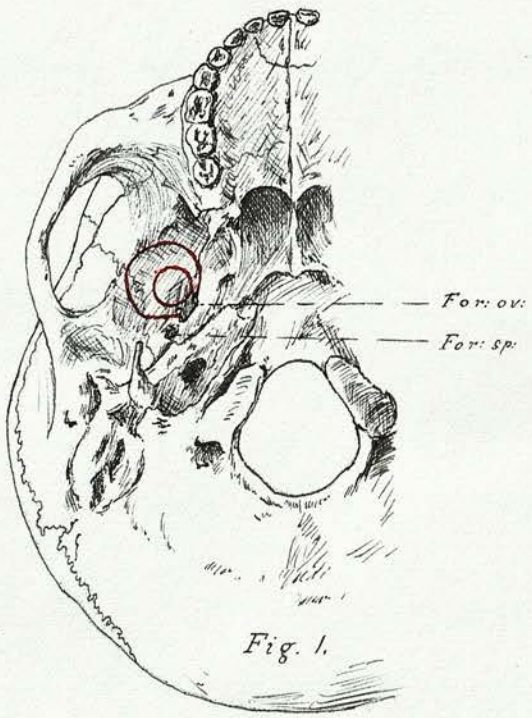

Fig. 1.

To show bone removed by Rose.

of the great wing of the sphenoid anterior and external to the foramen ovale so that its circumference just meets that of the foramen. The opening is enlarged with gouge or forceps. (Fig.1) The third division of the nerve is traced to the ganglion the posterior part of which is removed with portions of the second and third divisions. The zygoma, which is drilled before its resection, is replaced and wired and the wound closed.

The operation is one of the most complicated and difficult in surgery. After an elaborate dissection the surgeon has to carry on his manipulations at the bottom of a long and narrow funnel shaped wound, while he works in close proximity to important structures. He is in great danger of injuring the Eustachian tube, thus running the risk of infecting the wound. Haemorrhage is always profuse and exceedingly difficult to check, being derived chiefly from the pterygoid plexus of veins and vessels passing through the foramen and connecting that plexus with the cavernous sinus. The extensive destruction in the pterygoid region with resulting cicatrization is followed by a serious impairment of movement of the jaws interfering with mastication and in one case mentioned by Mr. Rose lead to almost complete closure. The disadvantages are sufficiently great.

On Aug. 8th 1891., sixteen months after Rose performed his first operation, Hartley of New York made an attempt to reach the ganglion from the lateral aspect through the temporal fossa. He was successful in exposing the ganglion, but was satisfied with the removal of the second and third divisions, the divided peripheral ends of which he tucked into their foramina.

Krause of Altona had for some months been working out on the dead body an operation differing only in some minor details from that of Hartley. He was however behind the latter in performance (Feb. 23rd 1892.)

After these two surgeons the method of gaining access to the ganglion by the lateral route is named 'The Hartley Krause Operation'. The adoption of the name must not be held to bind the writer to all the details employed by the two originators.

This which perhaps may be better termed 'the lateral operation', is the one now by far the most frequently performed, having practically supplanted that of Rose. It is intended later in this essay, after describing a case in which Professor Chiene operated by this method more than two years ago, and which was under the care of the writer in his capacity of house surgeon, to enter fully into the technique of the procedure, discussing the means by

which the difficulties of the operation may best be met and danger avoided, as appears to him from personal observation and a careful study of the work of others and chiefly that of Krause, Hartley, Keen and Tiffany.

It will be convenient here merely to indicate the steps.

An omega-shaped incision down to the bone marks out a flap with its base at the zygoma. The flap being turned down the greater part of the squamous temporal bone is laid bare. This is removed. The dura mater and contained temporo-sphenoidal lobe is then lifted from the floor of the middle fossa until the Gasserian ganglion and its branches are exposed. A variable portion of these are removed. Hartley and Krause both turn down a flap containing the bone as well as soft tissues.

The operation devised by Mr. Horsley here calls for mention. It differs essentially from all other plans hitherto proposed in that the attack is made on the roots of the fifth nerve, these being reached by freely opening the cavity of the dura and passing between that membrane and the temporo-sphenoidal lobe. On Mr. Horsley's own showing the operation was planned as the result of a false assumption. He says "I found when one

"attempted" (on the dead body) "to strip up the upper half of the ganglion from the cavernous sinus, it invariably tore the wall of that cavity. For this reason I believe that the operation of complete removal of the Gasserian ganglion is not possible". "Finding this to be the case, I then considered the possibility of dividing the fifth nerve behind the ganglion".

This deduction has since been proved to be incorrect by the frequent and successful removal of the entire ganglion by Krause, Keen, and other surgeons.

The following is an account of the procedure in Horsley's own words.

(After the cranial cavity has been opened by removal of the whole of the squamous temporal bone,) "The dura mater is then to be opened along the full length of the area of bone removed and the temporo-sphenoidal lobe laid bare". "The lobe is partly moulded, partly lifted upwards and the floor of the skull is then easily seen and illuminated with electric light. The guide to the fifth nerve now is the upper border of the petrous bone. The lobe being raised a little more, the edge of the tentorium will be defined, and the point at which the fifth nerve passes beneath it could in the first case I operated on be seen. The position of the

canal in which the nerve is lying just above the ganglion must then be estimated and a small puncturing incision made into it, and the dura forming its roof should then be further slit open. On exposing the nerve in the canal behind the ganglion I passed a small blunt hook round it, and it then occurred to me that the small branch of the basilar artery which accompanies the artery might give some trouble. I therefore thought one might safely attempt avulsion of the nerve from its attachment to the pons, and on gently drawing on it with a hook this was easily accomplished and without even any noteworthy oosing". "Unfortunately the patient never rallied from the operation, and died seven hours afterwards, obviously from shock". "At the moment when the fifth nerve was separated from the pons, although the patient was well under the anaesthetic there was arrest of the circulation and the pulse could not be felt. This lasted for probably not more than three or four seconds".

The result was not encouraging and the procedure has not been repeated. The sequence of events makes the cause of the fatal termination sufficiently clear. When the association of the fibres of the nerve with the nuclei in the medulla are called to mind, the sudden arrest of respiration and circulation at the time of avulsion of the

root is readily accounted for.

One other method only remains to be described, that brought to the notice of the profession by Doyen of Rheims in 1895. Doyen's operation may be said to hold a position intermediate between those of Rose and Hartley. Access to the cranium is gained by the removal of bone inferiorly and laterally. The incision is sickle-shaped as shewn in the figure (Fig.2). The handle or vertical portion of the incision is five or six centimetres in length, situated in front of the auricle and extends downwards a few millimetres below the zygoma.

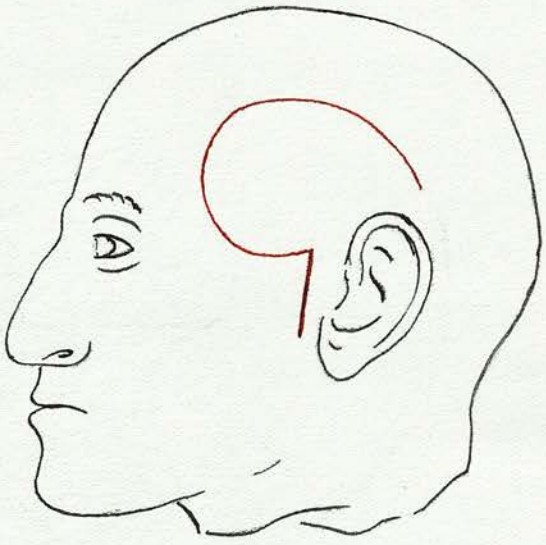

Fig. 2.

It must be made with care to avoid the branches of the facial nerve. The zygomatic arch is reseated, the coronoid process divided and the soft parts stripped from the temporal fossa.

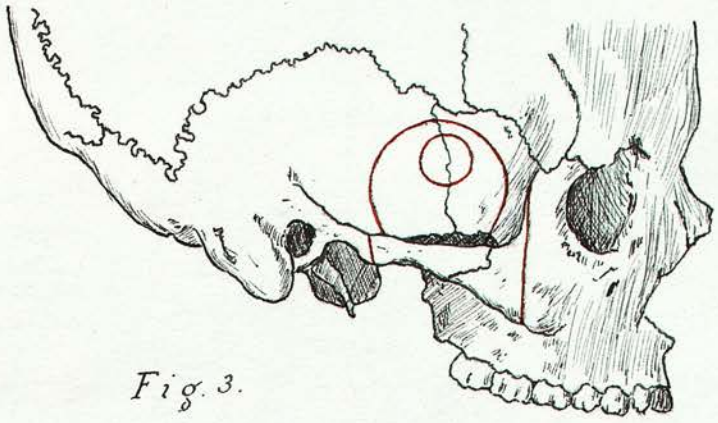

Fig. 3.

The lingual and inferior dental nerves are identified and divided as far forward as possible, being kept as guides. The internal maxillary artery is ligated near its point of origin. The pin of a trephine is placed at the sphenotemporal suture, so as to remove a disc of bone as shewn in the accompanying figure. That part of the great wing of the sphenoid which forms part of the wall of the middle fossa and

a portion of the squamous temporal adjacent is then removed bit by bit by means of suitable bone forceps. When the basal part of the great wing of the sphenoid is reached, that also is removed as far as the foramen ovale, the outer margin of which is cut away. The whole area of bone removed is shewn in figures 3 and 4.

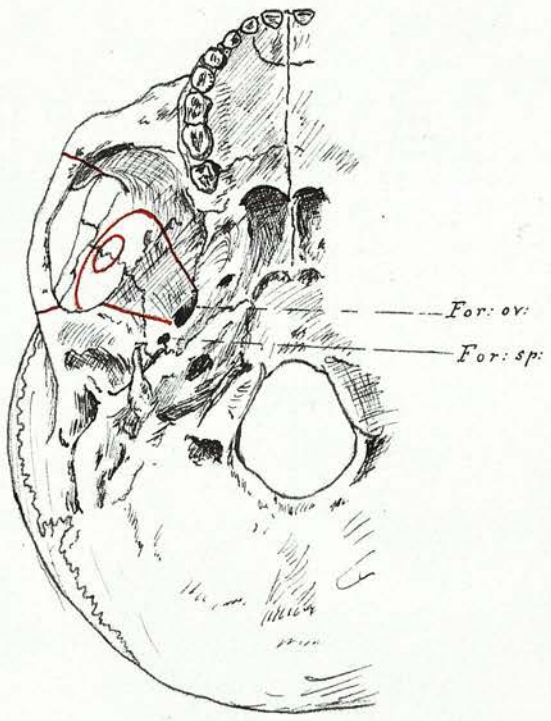

Fig. 4.

By means of the lingual and inferior dental nerves, which have been kept, the third division is gently raised and freed. The cavum Meckelii can now be opened from its outer side and the ganglion loosened from its attachments. The 2nd division is traced to the foramen rotundum and there divided. The 1st division is cut at the sphenoidal fissure. Finally, it is said, by gentle traction on the 3rd division and the careful use of a small dissecter, the ganglion may be made freely moveable and the roots of the fifth nerve can be severed.

Doyen claims that by this method the chances of injury to the brain are reduced to the minimum, since the temporo-sphenoidal lobe requires to be displaced to a much less extent than in the Hartley-Krause operation. In this latter plan however brain compression has but rarely led to a fatal result and there is reason to believe, as will appear hereafter, that such a contingency is always preventible. Undoubtedly much freer access to the deep structures is obtained than is possible in Rose's operation. Haemorrhage can therefore be more quickly and successfully dealt with, injury to the Eustachian tube should not be a danger, while it is possible to manipulate the nerves and ganglion with some degree of precision. On the other hand cicatricial contraction with consequent restriction

in movement of the jaw follows, as after Rose's operation. The operation is unquestionably one of grave severity and of much greater complexity than the Hartley-Krause, while the report of three cases published by Doyen is not favourable to its adoption, though it would, of course, be unfair to pass a final judgement on the results of so few cases. The first patient recovered and was entirely cured of her pain. Two and a half years later there had been no recurrence, but she complained that she could only with difficulty open her mouth. In this case about 15 millimetres each of the 1st and 2d divisions were removed, while the bulk of the ganglion with the 3rd division and 35 to 40 millimetres each of the lingual and inferior dental were taken away. Presumably it was not found practicable to divide the root as advised. The other two patients died. The death of the one on the fourth day was attributed to 'the extreme feebleness of the patient'; that of the other occurred suddenly on the tenth day with symptoms of 'apoplexy', 'when she seemed to be cured'.

Part II.

Surgical Anatomy.

Before proceeding to enquire into the means by which success may best be obtained in an operation admittedly of great difficulty, it is necessary to have an exact knowledge of the region in which the surgeon has to work.

It is not proposed to enter into a systematic description of the anatomy of the middle fossa, but only to emphasise a few facts which have a direct bearing on the operation, and some of which are scarcely noticed by the anatomist.

The protection afforded to the temporal region by its muscle and firm unyielding fascia may be mentioned in passing.

The middle fossa is practically bounded

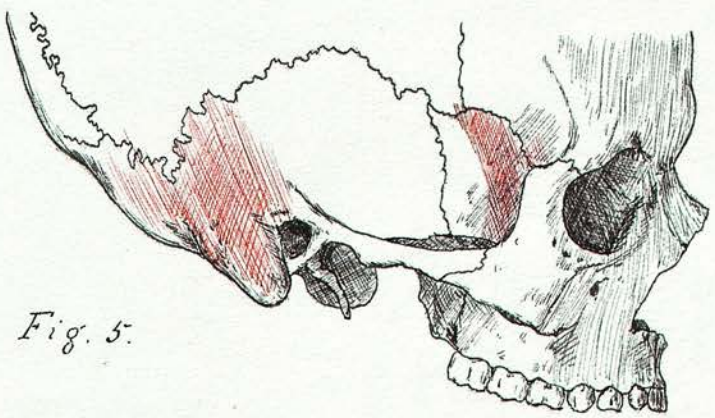

Fig. 5.

To show the position of thick bone.

externally by the squamous temporal bone, only a narrow strip of the great wing of the sphenoid entering into the formation of the wall. The posterior margin of the lesser wing of the sphenoid, which marks the anterior border of the middle fossa joins the lateral wall at a point from 1 inch to 1½ inches behind the external angular process of the frontal bone. Hence it is of no advantage to remove bone in front of that point.

The branches of the middle meningeal artery, which usually run in grooves in the lateral wall of the fossa, not infrequently in the old subject pass through canals in the bone and, when this occurs they may give considerable trouble where a bone flap is turned down.

The depression in which the temporo-sphenoidal lobe lies is deeply concave and the Gasserian ganglion lies on its postero-internal slope at the apex of the petrous bone.

The two roots of the fifth nerve emerge from the side of the pons and enter the middle fossa above the upper edge of the petrous bone and beneath, or more accurately through the wall of the superior petrosal sinus. The small motor root passes beneath the ganglion and joins the third division as a rule outside, but occasionally inside the skull.

The third division leaving the outer part of the ganglion passes downwards forwards and outwards, is ¼ inch or less in length and leaves the skull by the foramen ovale. The second division runs forwards, is about ½ inch in length and leaves by the foramen rotundum. The first, the thinnest and longest (about 1 inch) lies a little above and internal to the second and runs in the wall of the cavernous sinus escaping from the cranium by way of the sphenoidal fissure. Division of this branch behind the sphenoid fissure must result in wound of the cavernous sinus and structures in its wall.

The Gasserian ganglion lies beneath the main thickness of the dura mater, but a delicate sheath passes from that membrane beneath the ganglion and its branches. The ganglion is closely adherent to the dura above and this adhesion is largely due to its nutrient vessels, the arteriae receptaculi from the carotid and veins to the cavernous sinus. These though small are direct branches of main vessels, and therefore when torn across bleed so profusely that the operator may imagine he has made a rent in the sinus.

Internal to the ganglion is the cavernous sinus, with the first division of the Vth nerve, the IVth and IIIrd nerves in the substance of its

adjacent wall; the carotid artery and VIth nerve

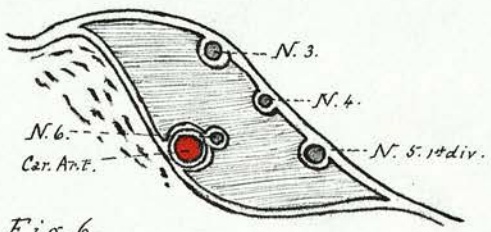

Fig. 6.

To show the relation of structures in the cavernous sinus. (Tr. sect. of rt: sinus - from behind) after Gray.

lie at the remote (inner) side of the sinus and can only be wounded after injury to the latter.

Below this however, i.e. below and behind the ganglion the carotid is only protected by a delicate fibrocartilaginous sheath, which in this portion completes the wall of the bony canal.

Along the upper border of the petrous above, behind the ganglion and in intimate relation to the roots of the Vth nerve runs the superior petrosal sinus.

The dura mater is firmly bound to the margins of the temporo-sphenoidal depression, anteriorly to the edge of the lesser sphenoid wing and sphenoidal fissure, posteriorly to the petrous bone, while internally it splits to form the cavernous sinus. The membrane is less firmly

adherent to the floor of the depression, but in old subjects its detachment from the bone may be a matter of great difficulty, (as in Mr. Chiene's case).

While numerous unnamed veins pass between the dura and bone, others of larger size run through the foramina. The middle menigeal accompany the artery of that name, while the emissary veins of Santorini connect the cavernous sinus to the pterygoid and pharyngeal plexuses by way of the foramina ovale and rotundum. Separation of the dura is followed by profuse haemorrhage from these sources.

The middle meningeal artery entering the skull by the foramen spinosum immediately becomes incorporated in the substance of the dura and this renders its ligation a matter of difficulty. Owing to the same fact it is easily torn across at its foramen if great care is not taken. The artery is valuable as a guide to the 3rd division and therefore it is of importance to have an accurate knowledge of the relative positions of their respective foramina. The foramen ovale lies anterior and internal to the foramen spinosum and the distance between them varies considerably. It is usually between 1/8 and

1/4 of an inch, but may be as far as 1/2 inch. In a skull at present before the writer the two apertures are separated by a bridge of bone not a 1/16 in. in breadth.

A small meningeal artery sometimes passes through the foramen ovale and may give rise to haemorrhage when dividing the 3rd division.

Part III.

A Case.

The following is a record of Mr. Chiene's case. W.C. aged 78, by occupation for many years a gentleman's servant, was admitted to the wards of the Edinburgh Royal Infirmary on Nov. 23rd 1897, suffering from severe neuralgia on the left side of his face. He had been a victim to his complaint for more than ten years, but of late years the pain had increased in severity. He had had frequent changes in medicinal measures, but benefit derived from them had never been more than transitory and they had long ceased to have any effect. Morphia had not been resorted to.

In February 1895 he first sought relief at the hands of the surgeon. At that time all three divisions of the nerve were affected, but the pain in the frontal region was by far the most intense. The supraorbital nerve was divided at its foramen and an attempt made to pull out the distal portion. This however broke, only about ¾ inch being removed. As the result of this operation the sufferer had a respite of from two to three months.

On readmission two years and nine months later the pain had increased both in severity and

area. It was worst over the supraorbital, malar, infraorbital and temporal regions, and was now accompanied by frequent 'epileptiform attacks'. The patient's own description of a spasm is perhaps worth recording. He said it felt "like as if every muscle and nerve in the left side of his head and face were vibrating and trembling with pain". What made his condition the more distressing was the presence of a tender patch on the side of the tongue. He looked forward to his meals with a feeling of dread, could only take liquids or soft solids and even then, and in spite of the greatest care, he was often unable to avoid the attack so much feared. Life spelt to him misery. When told that he might be relieved by an operation, but that it was one involving great risk, he implored that it might be tried, saying that if left as he was, his only prospect was the workhouse. Under these circumstances Mr. Chiene decided to make an attempt on the Gasserian ganglion and nerves intracranially.

On December 2nd 1897, Mr. Chiene operated. The anaesthetic employed was chloroform. The patient lay on his back with the head turned towards the sound side. A semicircular incision was made down to the bone marking out a flap with

a base 4 inches in length and corresponding to a line drawn from a point ½ inch behind the external angular process of the frontal bone to a point at the upper extremity of the posterior border of the mastoid process. Above the incision corresponded

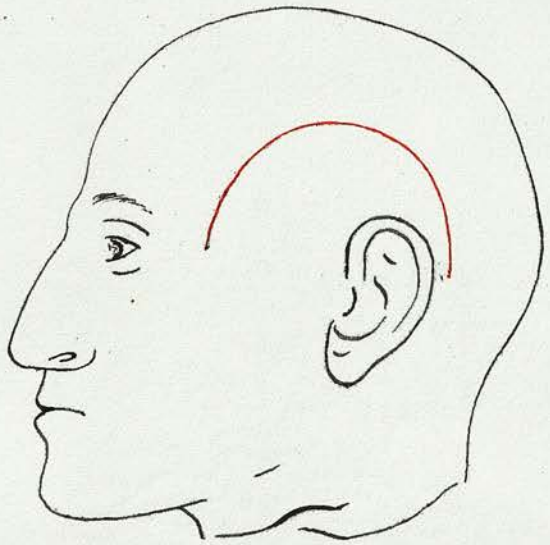

Fig. 7.

To show Chiene's incision.

to the upper temporal ridge. The flap containing all the soft parts included in the incision was stripped from the bone down to the level of the zygoma.

With a crown trephine a disc was removed from the squamous-temporal and the aperture thus formed was enlarged by means of forceps. The bone taken

away consisted of the squamous-temporal with the adjacent part of the sphenoid anteriorly and a portion of the parietal. The opening thus formed was irregular as shewn in the figure. It measured

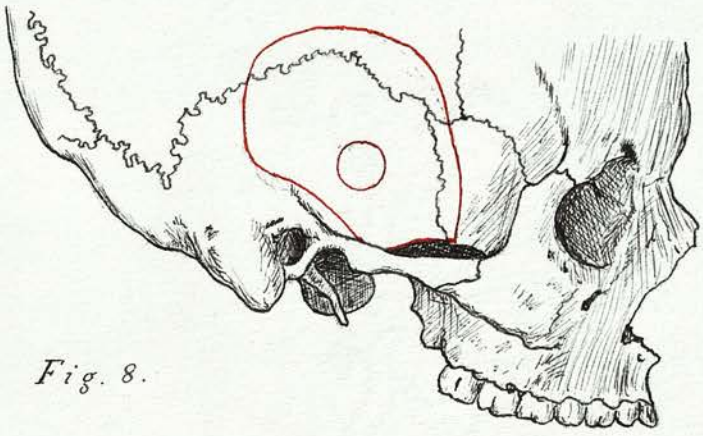

Fig. 8.

in its antero-posterior diameter about two and a half inches and its greatest vertical diameter was of the same length. At this stage there was some haemorrhage from branches of the middle meningeal, two of which required ligature.

Separation of the dura mater from the floor of the skull was then commenced. For this purpose the finger aided with a small blunt dissecter was employed. The membrane was found to be unusually

adherent to the bone and haemorrhage of a venous character was troublesome. From time to time it was necessary to plug the wound with gauze and wait until bleeding ceased.

When the trunk of the middle meningeal artery was reached a smooth retractor one inch in breadth was used to raise the temporo-sphenoidal lobe, the vessel was seized with forceps and its foramen plugged with a wedge of wood, which was then cut flush with the bone. While these manipulations were being carried out and during the succeeding steps of the operation a strong electric light was employed to illuminate the cavity. Continuing the separation of the dura inwards the third division was found at the foramen ovale and followed backwards. An incision was made with a tenotomy knife to open, it was believed, the cavum Meckelii. Several drams of cerebrospinal fluid escaped, shewing that the main cavity of the dura had been entered. This accident however proved to be an advantage gained. It was now found possible to obtain more space without any additional pressure on the brain lobe. A quarter of an inch of the third division was excised. The second division was then uncovered and a portion similarly removed. An attempt was then made to divide the ophthalmic trunk. This was followed by profuse haemorrhage.

The cavity rapidly filled with venous blood and it became apparent that the cavernous sinus had been injured. The wound was packed with a long strip of iodoform gauze one end of which was left protruding posteriorly, while the rest of the incision was united with horsehair sutures. A voluminous antiseptic absorbent dressing was applied in anticipation of an escape of cerebrospinal fluid.

In the evening the patient was fully conscious with a pulse of 92 of fair volume and tension. He had no pain. The top dressing required renewal, but the wound covered with several layers of gauze was left undisturbed.

Dec. 3rd. His general condition was much the same as on the previous evening. He answered questions correctly and took his food and stimulant well. He suffered no pain but said he 'felt something wrong below the left eye.'

Dec. 4th. He shewed incoherence in speech. When trying to explain some matter he failed several times, being quite unintelligible, though apparently knowing what he was talking about and taking great pains to make himself understood. At noon the wound was dressed and the gauze stuffing removed. The temperature rose during the afternoon reaching 100° at eight o'clock. The

patient became restless and then delirious making attempts to remove the dressing and get out of bed.

Dec. 5th. He was bright and intelligent and had entirely recovered from his aphasia. The thermometer registered 98°, while the pulse ranged from 80 to 90. Slight ptosis of the left eyelid was noticed.

Dec. 6th. He shewed signs of mental derangement, becoming restless and talking in a disconnected manner. His temperature and pulse remained normal.

Dec. 7th. His mental condition became worse. He was unruly and very talkative, rambling from one subject to another and making the most absurd statements and remarks. His pulse rose to 110 and became weaker. One tablespoonful of whisky every four hours was ordered. At 4-30 P.M. two drams of bromidia were administered and this was repeated at 9-30 P.M. and again at 2 A.M. Sleep followed.

Dec. 10th. After two quiet days his thoughts were still rambling and disconnected. Memory was much impaired. The dressings were removed and the wound found healed.

From this time the condition of the patient continued to improve, and he was discharged from

the hospital on January the 4th 1898. There had been no return of pain since the operation. There was diplopia on looking downwards and slight ptosis of the left eyelid. The eye itself was unaffected by the operation. There was complete anaesthesia over the areas supplied by the 2nd and 3rd divisions of the left fifth nerve and the muscles of mastication on the same side were paralysed.

On March 23rd 1900, almost two years and four months subsequent to the operation, when the writer personally examined him, the patient stated that he had suffered no pain since the day on which the operation was performed, but he said that 'the left side of face always felt swollen'. He had neither taste nor feeling in the left side of his mouth, and in consequence, when eating, his food occasionally escaped from his lips before he was able to prevent the accident. The muscles of mastication on the same side were useless and atrophied, but he made no reference to this fact until his attention was drawn to it. He then said 'I have to rely entirely on the right side'. There was an area of complete anaesthesia over the left cheek below the orbit and beyond the limits of this patch sensation was dulled to the extent

represented in the figure. The skin over the left infraorbital appeared slightly more shiny

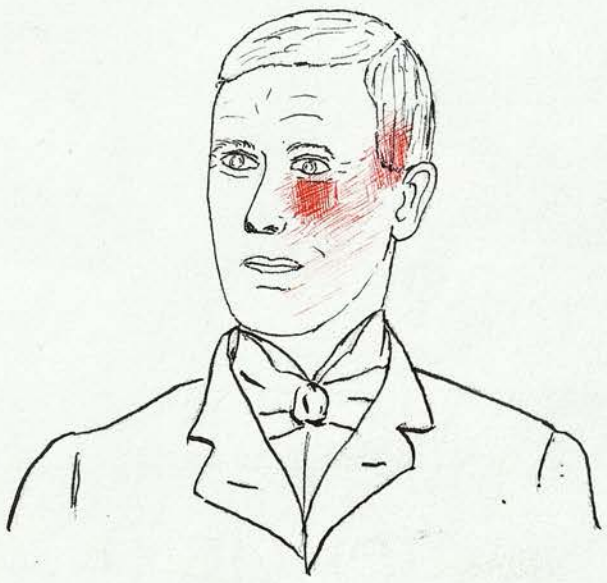

Fig. 10.

than that of the same region on the opposite side, but this was only noticeable on close inspection. The eye was healthy and the corneal surface clear, and the movements of the ocular muscles unimpaired. There was a distinct depression in the left temporal region, especially in its anterior part, but to moderate pressure with the finger the left temple seemed as firm as the right, while pulsation of the brain could not be felt.

Part IV.

The Lateral Extradural Operation.

The operation performed by Prof. Chiene, so successful in result, was essentially that introduced by and named after Hartley and Krause, though it differed in many minor details, even as the methods of the two originators do not entirely correspond.

It is proposed in discussing the technique to make use of the recorded experience of a number of surgeons with special reference to the work of the few, whose exceptional opportunities have enabled them to place before the profession experience gained from a series of cases.

Krause of Altona has performed Intracranial Neurectomy by the Lateral Extradural Method no less than eighteen times. Keen of Philadelphia has published in detail accounts of eleven operations, while Tiffany of Baltimore and Hartley of New York have placed on record ten and five cases respectively.

It is to be regretted that Mr. Victor Horsley's work is not yet available.

For present purposes it is convenient to

discuss the operation under the following headings.

(I) Preliminary.

(II) Incision.

(III) Removal of bone.

(IV) Separation of dura and treatment of the middle meningeal trunk.

(V) Treatment of nerves and ganglion.

(I) Preliminary.

With respect to the purification of the field of operation, it is perhaps not out of place to call attention here to the extreme difficulty in rendering the scalp sterile, and to urge that whatever the process employed for that purpose, it should be carried out with great thoroughness. It must not be deemed sufficient to shave only a portion of the scalp. The whole should be carefully purified and the auricle on the side of operation must receive careful attention. It is a wise plan to treat the area antiseptically for at least two days.

One of the main causes of difficulty in the operation is profuse venous bleeding. It would therefore seem rational to operate with the head high. For this reason Krause, making a compromise

with the anaesthetist, places the patient in a half-sitting posture. He also points out that, in the later stages of the operation, when the nerves and ganglion are being dealt with, the head should rest on the occiput, since in that position the blood is able to escape freely. If the head rest on its side even a few drops are sufficient to obscure from view in the depths of the cavity the delicate structures among which the surgeon has to carry on his manipulations.

In view of the venous congestion following the administration of ether, chloroform has been almost invariably employed. The notable exception is that of Keen, who used ether in all his cases. Krause tried ether for one patient who was the subject of valvular disease of the heart. The bleeding was so profuse that he was compelled to revert to chloroform.

(II) Incision and formation of the flap.

Krause turns down a flap including the bone to be removed. If a bone flap is to be made the incision through the soft parts must adapt itself to the bone which can be turned down. It must therefore be made with great accuracy. If the anterior extremity of the incision be made too

far forward the operator, when cutting the bone, will encounter the thick bone of the lesser wing of the sphenoid, encroaching on the anterior fossa, and will have difficulty in turning down his flap. If the knife pass too far back, the chisel will encounter the petrous bone.

Krause has taken account of these facts in planning his incision. This is horseshoe-shaped.

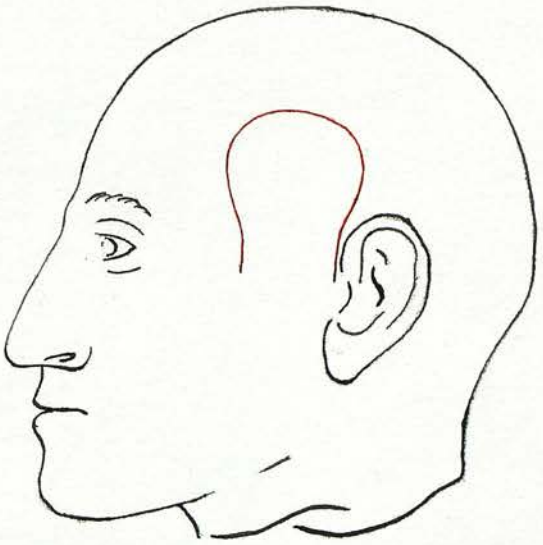

Fig. 9.

To show Krause's incision.

The base of the flap marked out corresponds with the upper border of the zygoma from a point immediately in front of the tragus for a distance

forwards of 3½ centimetres (1 3/8 inches) and in breadth 5 centimetres (about 2 inches).

Hartley recommends an incision of a somewhat similar shape. He says that the base corresponds with the zygoma, while the anterior extremity is at the external angular process. These statements are irreconcilable, since that process lies an inch above the zygoma.

If it should be intended to sacrifice the bone, a greater variety in the incision is practicable, since the flap need not correspond to the bone removed. There is undoubted advantage to be gained by making the incision through the soft parts include a wider area than that of the opening in the skull, for, if this plan be adopted, then during the process of healing a margin of the flap is supported on the bone edge and, when cicatrization has taken place, the temporal fascia and muscles remain stretched across the breach and the resulting depression in the temple is only slight.

These conditions were fulfilled in Prof. Chiene's case, and his incision (Fig.7) can only be improved in one particular. To render the removal of bone from the lower part of the temporal fossa more easy the anterior extremity must be as low as the zygoma. The posterior part of his

incision, passing as it does behind the ear, cannot injure the main temporal artery. Fowler in one of his operations slit the artery longitudinally as his knife passed in front of the tragus with the result that a considerable quantity of blood was lost.

(III) Removal of bone.

The anatomical conditions determining the extent of the bone flap, if employed, have already been referred to. It may be added that, although inexpedient to alter in any respect the base as recommended by Krause, a larger opening in the bone may be obtained by rendering his incision more convex posteriorly and carrying it somewhat higher. As Krause himself points out the aperture should be large for the purpose of allowing the brain pressed from below to expand laterally.

The instruments used for cutting the bone flap have been various. Hartley employs grooved chisels of a special make. Following the line of the incision he cuts down to the vitreous plate only, except above where the whole thickness of bone is divided. Here he inserts an elevator levering out the bone and thus snapping it along

the base of the flap. The irregular edge of the vitreous formed by its fracture is left as a shelf to support the bone replaced.

Krause used to work with a revolving circular saw, but now generally opens with Doyen's perforators and cuts out the flap by means of Dahlgren's forceps.

Tiffany maintains that there is 'no need to put the bone back'. He might have gone a step further and said, 'It is inadvisable to replace it' - for the following reasons. The operation is one of great severity and this is largely due to the time necessary for its accomplishment and to the considerable amount of blood inevitably lost.

The formation of a bone flap always lengthens the time and involves a greater loss of blood. Krause gives the average time necessary according to his experience - for the completion of the operation, when a bone flap is formed, as from 1½ to 1¾ hours; while he finished two cases in which the skull was opened by means of trephine and gouge-forceps, the one in 65 the other in 55 minutes. Much blood often escapes from the laceration of the branches of the middle meningeal artery, where they pass through canals in the bone (a common accident - occurring 8 times to Keen in

11 cases); while haemorrhage from the diploë is greater when the bone is cut through with a chisel or saw and may be very profuse and difficult to check as in a case reported by Fowler. Occasionally necrosis of the flap or a portion of it has taken place.

On the other hand where the bone is not replaced the temporal fascia muscle etc. form an efficient covering. In one case in which a previous operation had been performed by another surgeon, Tiffany was unable to tell before cutting down that the bone had been removed.

It may therefore be accepted that the rapid method of removal of bone by means of the crown trephine and forceps is the one which is best suited to the needs of the operation under discussion.

The opening made by Prof. Chiene gives sufficient access (Fig.8.). It is especially important to remove the bone as far down as the antero-posterior ridge which divides the lateral from the inferior surface of the great wing of the sphenoid bone. If this is done, the succeeding steps of the operation are rendered easier.

IV. Separation of the dura, and treatment of the middle meningeal artery.

The separation of the dura and raising of the tempero-sphenoidal lobe may be a matter of great difficulty, as in Mr. Chiene's case. Haemorrhage of a venous character is always considerable and may be profuse from the numerous veins passing from the membrane to the bone and from other sources, which have been mentioned in a previous page.

It is best to commence the procedure with the finger aided by a blunt dissecter, When the lobe has been raised from the outer part of the fossa, Krause substitutes for the finger small swabs of gauze held by haemostatic forceps. These serve

Fig. 11. A suitable form of dissecter.

the double purpose of pushing aside the dura and absorbing the blood effused. From time to time it is necessary to stuff the cavity formed between

bone and membrane with gauze and wait until haemorrhage ceases. In a case operated on by Bland Sutton hot sponges were employed without any ill effect to the brain.

Thomas of Cardiff refers to the great benefit he has derived from the use of Horsley's paste, which he freely smears over the bone surface as it is exposed.

On a number of occasions the cavity of the dura has been opened accidentally. Every one to whom the accident has happened makes mention of the advantage gained by its occurrence. There is always a free escape of cerebro-spinal fluid. It is found as a result that the brain may be raised higher without the employment of any additional pressure. Weeks says "the escape of cerebro-spinal fluid rendered the raising of the brain safer and easier." Tiffany who has purposely incised the dura speaks more emphatically. "The opening of the dura and evacuation of cerebro-spinal fluid is followed by great benefit, the later stages of the operation become vastly more easy." Where the brain has not itself been injured no harmful result has followed. Indeed by providing a free outlet for the escape of the cerebro-spinal fluid sudden and injurious pressure

on the medullary centres is less liable to occur. When the temporo-sphenoidal lobe is compressed pressure on the fluid in the dural sac is raised throughout, the fluid surrounding the brain and that within the ventricles being in free communication through the roof of the fourth ventricle. An incision in the dura acts as a safety valve by allowing a rapid diminution in the volume of the fluid contained.

In Fowler's first case death took place shortly after the patient left the table and was attributed to injurious brain pressure. 'The lobe was lifted and compressed for fifteen minutes'. During this time breathing became stertorous. Respiration rapidly fell in frequency shortly after the conclusion of the operation and finally ceased. Had the dura been opened in this case, perhaps the fatal result might have been averted.

It would therefore seem advisable to puncture the dura in all cases.

At the foramen spinosum the dura is anchored by the middle meningeal artery and its accompanying veins. The opinion of operators is almost unanimous that it is necessary to divide this artery, though Tiffany has 'not found it in the way at its entrance to the skull'. One can only suppose that

in his cases the foramena spinosum and ovale were far removed from each other. Be this so or be it not so, the division of the artery always renders the subsequent manipulations of the nerves and ganglion more easy, and, since the collateral circulation in the dura is free, there is no advantage to be gained by attempting to save it. On several occasions the trunk has been ruptured at its foramen while raising the lobe. This happened to Keen in three of his operations, and to Fowler 'in spite of great care' once. The bleeding was stopped by plugging with a narrow strip of gauze, which was left in for three days. The usual plan adopted has been to ligate the vessel. This is always difficult owing to its depth from the surface (1½ inches or more). Mr. Chiene's plan of plugging the foramen with a wedge of wood is easier. It is also safer since the risk of a ligature slipping from the necessarily short stump is avoided.

The trunk of the middle meningeal artery is a guide to the foramen ovale, which lies in front of and internal to the foramen spinosum, and at a distance varying from 1/16 inch to 1/2 inch.

The separation of the dura from the nerves is best accomplished by the aid of the blunt dissecter and small pads mentioned above, the brain being held

in position by a blunt and smooth retractor.

(V) Treatment of nerves and ganglion.

The question as to the exact amount of the fifth nerve within the skull which it is advisable to remove is still 'sub judice'. It can only be discussed after the result of cases hitherto operated on have been enquired into. It may for convenience here be stated, that never should the surgeon be satisfied with the removal of less than the 2nd and 3rd divisions and the corresponding part of the ganglion. In a number of cases in which less than this amount only has been taken away pain has returned with great intensity.

Krause, who from his work may be considered a high authority, now removes the whole of the ganglion in each case. It would appear that there are instances in which the removal of the ganglion is impracticable, but it must not be forgotten that impracticability may depend not only on anatomical conditions present, but also on the qualities of the operator.

In his last sixteen cases Krause has not failed to remove the whole ganglion. His method is at the same time the most thorough and the most exact which has been employed, while it has been followed

by the best results.

For these reasons it will be described in detail.

When the 2nd and 3rd divisions have been exposed and freed from their attachments by means of pledgets of gauze and a blunt dissecter, they are left intact to act as guides and to keep the ganglion fixed, while it also is isolated. This may as a rule be accomplished by the same means (gauze pledgets and dissecter) though occasionally it is necessary to cut a few strands of fibrous tissue forming the outer wall of the cavum Meckelii. This is best done by means of pointless scissors. No pointed instrument should be used in the manipulations on the ganglion, for this is separated from the carotid artery inferiorly and posteriorly only by a thin fibro-cartilaginous sheath.

By exerting gentle traction on the 3rd division held by forceps or a small blunt hook the process of loosening the ganglion from its bed is facilitated. In every operation Krause succeeded in freeing it to its internal edge and posteriorly as far as the root. No attempt is made to cut the 1st division.

When isolated the ganglion close to the root is seized in forceps of a special pattern, care being taken not to include in the grip any dura

mater. Then and not until then the 2nd and 3rd divisions are cut through at their respective foramina. The forceps are now slowly turned on the axis of the instrument. Part of the root as well as the 2nd and 3rd division generally comes away, the 1st division tearing close to its origin.

The forceps used for grasping the ganglion must not have sharp serrations, so that the delicate nerve fibres may not be cut through. The blades should be curved near their extremities, the curve being in the plane of the handles.

If a clear view of the ganglion be not obtained, there is a great risk of wounding the cavernous sinus. This accident is not of such serious import as might be supposed. It has happened to a number of operators. The haemorrhage resulting is always readily controlled by plugging the wound with gauze. Krause in one of his cases damaged the sinus wall before the completion of the operation. He was able to check the bleeding by means of a small swab held in artery forceps, until he had removed the ganglion. He then allowed the brain to sink back into position, leaving no tampon in the wound, when haemorrhage ceased. Surely the risk involved in this procedure is great. It is far safer to stuff the wound with a strip of gauze, which may be removed

in 48 hours. Keen in one of his successful cases left 322 square inches in the wound for three days.

If the operation requires to be stopped owing to haemorrhage from the cavernous sinus, it may be completed on the 3rd or 4th day after, though it must be remembered that to operate in two stages is to increase the risks of sepsis.

It is the best practice to leave a drain in every case. Where this precaution had not been taken Tiffany lost a patient. Within an hour after the operation, the upper extremity became paralysed. The wound later proved to be septic and when the stitches were removed a decomposing clot was found.

The secret of Krause's success in complete removal is largely due to the fact that he does not divide the 2nd and 3rd divisions until he has freed the ganglion.

Remembering the experience of Horsley, when on tearing the roots of the Vth nerve away from the pons the respiration and pulse of his patient were at the time arrested and the operation was followed by a rapidly fatal result, one is led to ask - Is not avulsion as practised by Krause liable to be followed by a similar catastrophe? This hitherto has not happened to him. The explanation may perhaps be found in the fact that the

roots generally tear at a point between the ganglion and brain, probably where they pass through the wall of the superior petrosal sinus. In several cases the whole of the roots have been pulled away and on one occasion (Case 54.) death from shock followed in seven hours, though there was nothing in the symptoms to show that it was caused by the avulsion of the roots.

This risk could always be avoided in cases in which the roots can be easily uncovered by section behind the ganglion. In those instances in which owing to their attachments they cannot be freed, it is unlikely (owing to those very attachments) that the roots would come away in their whole length.

Other means for the destruction of the ganglion have been employed, but do not commend themselves. Such are, removal with curette, or with blunt hook (Bland Sutton) or piecemeal by forceps. In three cases Keen 'destroyed' the ganglion and left it in situ. In two of these pain recurred.

It has been suggested that the motor root should be spared if possible, though few attempts have been made to save it. Keen does not think that it is possible, since it is very adherent to the t3rdd division. Krause on one occasion succeeded in separating it from the ganglion, but found it could not be detached from the third

division. Chambers (Case 45) in the success of his attempt failed to attain the main object of the operation. Pain returned within a week, probably owing to incomplete removal of the sensory fibres of the inferior maxillary nerve.

Perhaps in rare and favourable cases the root might be saved, but considering the fact that its removal results at the most in only trivial inconvenience to the patient, it is scarcely justifiable to sacrifice time in trying to preserve it.

Part V.

Results and conclusion,

When one turns to enquire into the results obtained from the performance of the operation which has been discussed, he is disappointed to find that the scientific value of a collection of the published cases is greatly diminished owing to the incompleteness of the records.

The writer has been able to find descriptions, more or less complete, of 88 operations by the Lateral Extradural Method, but in comparatively few of these has a statement of the patient's con-

dition been made at a length of time after the operation sufficient to show the result with respect to permanency of cure.

The fact of the statistics however present many points of interest.

The main facts to be sought are those which have relation to the mortality depending on the operation, to its efficacy as a therapeutic measure, and to its concomitant unbeneficial effects.

(a) Mortality.

In the 88 cases examined there are 15 deaths. This gives a percentage of 17·04. Of these septic infection was responsible for 6, Brain injury and shock hold the 2nd and 3rd places. The following is a list of the causes -

(Sepsis	5.
(Brain abscess	1.
Shock.	3.
(Brain compression.	2.
(Brain laceration.	2.
Heart failure.	1.
Exhaustion owing to haemorrhage	1.

This does not aim at being a scientific division but

has been adopted as one of clinical convenience. Thus 'Brain abscess' has been placed apart from 'Sepsis', because it exhibited its symptoms at a time remote from the operation, after the patient had apparently gained his usual health. This case No,74. in the table) brings into prominence the insufficiency of the reported results, many of which have been published only a few weeks after the operation.

Of the cases included under 'Sepsis' one requires special mention - No. 37, already referred to, in which no drainage was employed and sepsis occurred in a blood-clot.

The heading "Brain laceration' comprises two fatalities following severe injury to the temporo-sphenoidal lobe during the process of bone-removal. The one (No. 27.) was caused by the slipping of a trephine into the substance of the brain, the other (No. 73) resulted from the breaking of a pair of bone-forceps, the fragment of the instrument being 'hurled into the brain'.

Two deaths (Nos. 58 & 81) were directly caused by undue compression while raising the temporo-sphenoidal lobe from the floor of the skull. It has already been suggested that this accident might

be avoided by incision of the dura mater.

In one case death was attributed to 'heart failure' and occurred on the 6th day. The patient (No.6) was an old man of 72, very weak and the subject of valvular disease of the heart and arteriosclerosis. Krause at first refused to operate, but afterwards was prevailed upon by the patient to do so.

Only one death has been attributed to haemorrhage (No. 78) Nicholson states that the skull in this case was half an inch in thickness with the middle meningeal artery running in the bone, that the section of the bone flap required an hour on account of the haemorrhage, which he describes as 'terrific'. The patient died of 'exhaustion' four days after the operation.

(b) The efficacy of the operation as a therapeutic measure.

In relation to this question the majority of the cases collected are of no value.

In many cases of extensive extracranial operation for removal of nerve trunks pain recurs after a period of immunity of from 9 months to 2 years. It is therefore impossible to say that a cure has

been effected until at least 2 years have elapsed since operation.

The immediate effect of removal intracranially of the divisions affected, either with or without the ganglion, has been cessation of pain in the area of distribution. The period of relief in those cases in which pain returned has usually been measured by months. In case 45 in which a respite of only one week was obtained, there is little doubt that the sensory fibres of the inferior maxillary nerve had not been all removed.

It would, for reasons given above, be useless to attempt to deal with this matter in terms of percentages.

It therefore remains to make enquiry into the conditions obtaining in those cases in which pain is known to have returned, and to endeavour to find any class of case in which pain recurrence has never been known.

There are ten cases in which return of pain has been reported. Of these -

in four (Nos. 1. 31. 55. 65.) a portion of the second division only was excised (in 55 the third was cut). In all of these trouble again started in the third.

In two (Nos. 19.20) the second and third divisions were excised and the ganglion broken up but not removed.

In No. 82. the second and third division only were removed.

In No. 47. the second and third were excised and the ganglion curetted.

In No. 52. the second and third were excised and the ganglion picked away.

No. 45. the remaining case has already been mentioned. In this the ganglion was curetted and an attempt made to save the motor root.

In seven of these operations no attempt was made to remove the ganglion, in the other three the methods adopted were such as to leave room for doubt as to its complete removal.

On the other hand in no instance in which the ganglion has been removed entire has pain recurrence been reported. Krause in a recent paper (Handbuch der Prakt. Chirurg. 1899. p. 621-699) states that he has not failed to remove the ganglion entire in his last 16 operations and in no case has pain returned. Of these patients two are dead. Of the fourteen

living, one was operated upon more than 6 years ago, one over 5 years, and two over 4 years. The details of the other cases are not on record, but we may presume that in several of them the period since operation is over two years. One patient of Keen in which the whole ganglion was avulsed has remained well for over two years. There are three cases (not including Krause's) in which this procedure was carried out and the period of relief is between one and two years. It does not appear that the risks of a fatal result are increased by removal of the whole ganglion.

From the above facts we may infer that in any case cure can only be looked for with any degree of certainty, when the removal of the Gasserian ganglion has been complete.

(c) Concomitant unbeneficial effects.

The only harmful effect of a serious nature, (except those already mentioned as being a danger to life), is corneal ulceration with consequent impairment or loss of vision on the side of operation.

Ulcer of the cornea is noted eight times in the table. This however must not be accepted as a

trustworthy record, for in many cases an account of the state of the eye subsequent to operation has not been given. In four of these cases the eye was destroyed; in the remaining four vision was more or less impaired.

If an enquiry be made into the procedure adopted in treating the nerves and ganglion in these cases, it is found that the accident has in all followed an attack on the ganglion itself, though in No. 38. there was a deep ulcer at the time of operation and this had curiously enough developed at some time subsequent to removal of the 2nd division two and a half years previously.

In five out of the seven operations (omitting Case 38) the ganglion was removed entire, in one it was curetted, while in the seventh it was broken up and left.

It is impossible from the data hitherto obtained to form any estimate of the frequency of the occurrence of corneal ulceration in relation to the various methods of treating the ganglion.

If it should hereafter be proved that excision of the 2nd and 3rd divisions with the clean removal of the corresponding part of the ganglion, as advo-

cated and practised by Tiffany, is as certain of effecting a cure as is complete excision of the ganglion, then this method will be adopted. By this plan the ophthalmic division and the portion of the ganglion from which it springs is left intact. It is to be regretted that in no case in which Tiffany has employed his method is there a record of the patient's state sufficiently late to show the result.

It cannot be denied that the risk of the loss of an eye calls for grave consideration. It would appear however that this serious consequence is not of frequent occurrence and is probably nearly always preventable. Of the four eyes already mentioned as requiring enucleation, in one the cornea was on the point of giving way at the operation and the other was atrophic. By careful treatment of the eye ulceration may generally be prevented or if it occur may be limited. Its chief causes are anaesthesia with consequent non-removal of foreign bodies, and dryness from deficient secretion of tears.
The question as to the government of the nutrition of the cornea by the Gasserian ganglion is a debated point. Turner (B.M.J. Nov. 1895.) from a number of experiments on animals concludes that "there is no

evidence of trophic influence exerted by the Gasserian ganglion upon the cornea, and, provided septic organisms are excluded the ophthalmic branch may be safely divided or the Gasserian ganglion removed without fear of disorganization of the eye."

The eye should in all cases be protected after operation and daily bathed with a non-irritating antiseptic lotion.

Other injurious complications following the operation require little more than naming. Conjunctivitis frequently occurs. Paresis of the 4th 6th or 3rd nerves are not uncommon but usually of short duration. Aphasia, when it supervenes, is generally slight and soon disappears. The trifling inconvenience caused by atrophy of the muscles of mastication on the side of operation is well exemplified in the case of Mr Chiene's patient. Anaesthesia in the area of distribution of nerves removed must of necessity be looked for, and in the mouth gives rise to the collection of food particles inside the cheek and their occasional escape from the lips, an accident which the patient soon learns to avoid. The deformity caused by the wound is not marked and is

in part concealed by the hair.

As a result of an enquiry into the subject of Intracranial Neurectomy and Excision of the Gasserian Ganglion, it may be concluded that the operations hitherto devised are to be regarded as measures of grave severity. The Lateral Extradural Method holds its own as the most sound as a surgical operation and has been followed by the smallest deathrate. But even this operation presents a high mortality (over 17 p.c.), and is only rendered justifiable by the terrible nature of the affliction it is designed to cure. Until greater perfection in technique has materially reduced its mortality, the operation must remain a 'dernier resort'. That an improvement in this direction will soon be shewn, we are surely justified in hoping, when we find that more than a third of the deaths in the past have been caused by septic infection.

Further - if the operation is undertaken at all, the aim must be to make it complete - the whole ganglion must if possible be removed. Where this is done the risks to life are not increased, while the probabilities of cure approach certainty.

One must not court failure in the main object, even to avoid the possible loss of an eye.

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by J. Lynn Thomas. F.R.C.S. Cardiff.

B. M. J. 1898. I. 487.

THOMAS.

"Notes on two recent operations upon the Gasserian ganglion and the second and third division of the fifth nerve for neuralgia."

by J. Lynn Thomas. F.R.C.S. Cardiff.

B. M. J. 1899. II. 1080.

MARCHANT.

"De la résection du ganglion de Gasser dans les névralgies faciales rebelles".

by Drs. Marchant et Herbet.

Rev. de chir. 1897. XVII. 287-318.

DEPAGE. "Un cas de résection de ganglion de Gasser".

by A. Depage.

Bull. Acad. Roy. de Méd. de Belge.

1897. XI. 687-694.

DEPAGE. "Un deuxième cas de résection du ganglion de Gasser, opéré avec succès par le procédé de Krause".

by A. Depage.

Bull. Acad. Roy. de Méd. de Belge.

1898. XII. 294-301.

LATERAL EXTRADURAL OPERATION.

Case	Surgeon's name	Sex.	Age.	Date of op:	Div:afftd	Treatment of nerves & ganglion,	Result as to pain.	When observed.	Remarks.
1.	Krause.	F.	47.	Feb.23.92.	2.	2nd only excised.	Severe pain.	in 8 mo.	
2.	do.	M.	64.	Dec. 3.92.	2.	2 only excised.	No pain.	3 mo.	
3.	do.	F.	68.	Jan.31.93.	1. 2. 3.	2 & 3 gan. & root removed.	No pain.	6 yr.	
4.	do.	F.	48.	Apl.29.93.		3 gan. and root removed .	No pain.	6 mo.	Same patient as 1. 2nd division already removed. Died of perityphlitis 6 months later.
5.	do.	M.	55.	May 30.93.		2 & 3 & gan. removed.	do.	5 yr.8 mo.	
6.	do.	M.	72.	Nov. 3.93.		These have not been published in detail.			Death - hoart failure - 6 days.
7.	do.	F.	71.	Sep.19.94.		The ganglion was removed entire in all and in none had there been recurrence	No pain,	4 yr.4 mo.	P. suffered from valvular disease.
8.	do,	F.	36.	Nov.29.94.		at the time of Krause's last paper on the subject, (Handbuch der Praktischen	do.	4 yr.2 mo.	
9.	do.					Chirurgie 1899. p. 621-669.)	do.		Corneal ulceration in two cases; eye lost in one; slight opacities remained in the other.
10.	do.					One case died four weeks after the operation, death being attributed to cholesteatoma of the arachnoid.	do.		
11.	do.						do.		
12.	do.						do.		In one case paresis of 6th nerve for a week; in another the 3rd nerve was paralysed and did not recover for 10 weeks.
13.	do.						do.		
14.	do.						do.		In two cases necrosis of bone flap.
15.	do.						do.		

LATERAL EXTRADURAL OPERATION.

Case	Surgeon's name	Sex.	Age.	Date of op:	Div:afftd.	Treatment of nerves & ganglion.	Result as to pain.	When observed.	Remarks
16.	do.	M.	30.						
17.	do.								
18.	do.								
19.	Keen.	M.	41.	Oct.18.93.	1. 2. 3.	2 & 3 exc. gan. broken up.	Pain less severe.	3 yr.11 mo.	The spasms did not return.
20.	do.	M.		Jan.18.94.	2.	do.	Pain returned.	3 yr. 3 mo.	Corneal ulcer; eye lost.
21.	do.	F.	63.	Feb.20.95.	2. 3.	2 & 3 & gan. removed.	-	-	Death - 7 days - sepsis.
22.	do.	F.	60.	May 23.95.	2. 3.	2 & 3 exc. gan. broken up.	No pain.	3 yr,	Necrosis of bone flap.
23.	do,	F.	54.	Oct. 6.95.	2. 3.	2 & 3 exc:,pt: of gan:curet.d	do.	2 yr, 4 mo.	Corneal ulcer which healed.
24.	do.	M.	33.	Nov.22.95.	1. 2. 3.	2 & 3, gan: & roots avulsed.	do.	1 yr. 11 mo.	Corneal ulcer; Vision impaired.
25.	do.	M.	76.	Dec.31.95.	1. 2. 3.	2 & 3, gan: & pt: of roots avulsed.	do.	2 yr. 5 mo.	
26.	do,	F.	69.	Jan.24.96.	1. 2. 3.	2 & 3 & gan: avulsed.	do.	1 yr. 8 mo.	
27.	do.	M.	49.	Apl.21.96.	1. 2. 3.	2 & 3 & pt: of gan: avulsed.	-	-	Death - 3 days - brain injury.
28.	do.	F.	63.	Oct.31.96.	1. 2. 3.	do.	-	-	Death - 10 hours - shock.
29.	do.	M.	56.	Jan.22.97.	3.	2 & 3 & gan: avulsed.	No pain.	1 yr, 4 mo.	Corneal ulcer; eye lost.
30.	Tiffany.	F.	59.	Sep. 8.92.	2. 3.	2 & 3 & pt: of gan: removed.	No pain.	1 yr, 1 mo.	

LATERAL EXTRADURAL OPERATION.

Case	Surgeons name	Sex.	Age.	Date of op:	Div:afftd.	Treatment of nerves & ganglion,	Result as to pain.	When observed.	Remarks.
31.	Tiffany.	M.	69.	Feb.2. 93.	2.	2 removed.	Pain severe.	less than 1 yr.	Pain returned in 1 and 3.
32.	do.	F.	78.	Jun.30.93.	2. 3.	2 & 3 & pt: of gan: removed.	No pain.	4 mo.	
33.	do.	F.	46.	Oct.25.93.	2. 3.	do.	do.	2 mo.	
34.	do.	F.	69.	May 9.94.	2. 3.	do.	do.	1 mo.	
35.	do.	M.	63.	Nov.19.94.	2. 3.	do.	do.	1 mo.	
36.	do.	M.	76.	Mar.22.94.	2.	2 removed.	do.	1 mo.	
37.	do.	M.	71.	Oct. 95.	2. 3.	Not given.	-	-	Death - 3 weeks - sepsis.
38.	do.	M.	70.	Oct. 95.	1. 3.	3 & gan: also piece of 1 removed.	No pain.	1½ mo.	Same patient as No.31. Corneal ulcer before op: eye lost.
39.	do.	M.	71.	May 96.	2.	None removed. 2 already gone.	-	-	Death-3½ weeks - sepsis.
40.	Hartley.	M.	46.	Aug.15.91.	1. 2. 3.	2 & 3 removed.	No pain.	1 yr, 5 mo.	Paresis of nerves 3, 4 & 6; temporary.
41.	do.	M.	60.	Mar. 95.	2. 3.	2 & 3 exc:, gan: curetted.	do.	1 yr, 1 mo.	
42.	do.	M.	43.	Apl. 95.	2. 3.	do.	do.	1 yr.	
43.	do.	F.	50.	Jun. 95.	1. 2. 3.	do.	do.	10 mo.	
44.	do.	F.	47.	Jun. 95.	1. 2. 3.	do.	do.	10 mo.	
45.	Chambers.	M.	47.	Jan.31.94.	2. 3.	Sens:fibres picked away; gan: curetted.	Pain returned.	within 1 wk:	No paralysis of jaw muscles. Conjunctivitis fo 10 d. Motor root saved.

LATERAL EXTRADURAL OPERATION.

Case	Surgeon's name	Sex.	Age.	Date of op:	Div:afftd.	Treatment of nerves & ganglion.	Result as to pain.	When observed.	Remarks.
46.	Chambers.	M.	46.	Jun. 22.95.	2.	2 & 3 exc:, gan: curetted.	No pain.	1 mo.	
47.	do.	M.	55.	Sep. 18.95.	2. 3.	do.	Slight pain.	7 mo.	
48.	do.	M.	62.	Oct. 19.95.	2. 3.	2 & 3 & gan: removed.	No pain.	4 mo.	Conjunctivitis.
49.	Czerny.	F.	37.	Jun. 13.93.	2. 3.	2 & 3 removed.	do.	1 yr. 7 mo.	Necrosis of bone flap.
50.	do.	M.	64.	Oct. 25.93.	1. 2.	2 removed.	do.	1 yr. 4 mo.	
51.	do.	M.	24.	Dec. 17.94.	2. 3.	2 & 3 removed.	do.	2 mo.	Slight pain over 2 & 3 area, before stuffing removed.
52.	Finney.	F.	47.	Sep. 7.93.	1. 2. 3.	2 & 3 exc: gan: picked away.	Pain returned.	-	When or how severely not stated.
53.	do.	M.	63.	do.	?	do.	No pain.	?	
54.	do.	M.	69.	Sep. 15.93.	3.	2 & 3, gan: & whole root avulsed.	-	-	Death - 7 hours - shock.
55.	Thomas.	F.	61.	Dec. 17.94.	2. 3.	2 removed. 3 divided.	Some in 3.	3 yr.	Op: stopped owing to state of patient.
56.	do.	M.	51.	Sep. 2.98.	1. 2. 3.	2 & 3 removed; gan: damaged.	No pain.	10 mo.	Foramina plugged with Horsley's wax.
57.	do.	M.	34.	Feb. 9.99.	2. 3.	2 & 3 & outer pt: of gan: removed.	do.	8 mo.	do.
58.	Fowler.	F.	45.	Aug. 10.93.	?	2 removed.	-	-	Death - shock from brain compression.
59.	do.	M.	42.	Feb. 10.94.	2. 3.	2 & 3 removed.	No pain.	2 yr. 2 mo.	Ext: carotid ligatured.
60.	do.	M.	50.	Apl. 28.94.	2. 3.	2 & 3 divided (op: stopped)	-	-	Death - 5 days - sepsis. Ext: carotid tied but venous haemorrhage great.

LATERAL EXTRADURAL OPERATION.

Case	Surgeon's name	Sex.	Age.	Date of op:	Div:afftd.	Treatment of nerves & ganglion.	Result as to pain.	When observed.	Remarks.
61.	Abbe.	F.	55.	Jan.21.95.	1. 2. 3.	2 & 3 exc:, gan: curetted.	No pain.	3 mo.	
62.	do.	F.	65.	Oct.12.95.	1. 2. 3.	2 & 3 removed.	do.	?	
63.	Deaver.	F.	44.	Mar. - 94.	?	2 & 3 removed.	do.	12 days.	
64.	do.	?		Mar. - 94.	2.	do.	do.	?	
65.	Schlange.	M.		Aug. 4.93.	2.	2 removed.	Pain in 3.	within 1 yr,	
66.	do.	M.	59.	Jan.31.94.	2. 3.	2 & 3 removed.	No pain.	11 mo.	
67.	M.^{c} Burney.	F.	64.	Jly.27.92.	1. 2. 3.	2 & 3 removed.	do.	1 mo.	
68.	do.	M.	51.	Dec. 9.92.	1. 2. 3.	do.	?	?	Paresis of 3rd nerve.
69.	Gerster.	M.		Feb.25.95.	2.	2 & 3 exc:, gan: picked away.	-	-	Death - 8 days - sepsis.
70.	do.	F.	34.	Jly.27.95.	2. 3.	3 & gan: avulsed.	No pain.	8 mo.	2 found reduced to a thread after Lossen's op:.
71.	Murphy.	F.	51.	Dec.26.95.	1. 2. 3.	2 & 3 & gan: removed.	do.	5 mo.	
72.	do.	M.	62.	Apl. - 96.	2. 3.	do.	do.	2 wk.	
73.	Lange.	M.	64.	Oct.11.93.	2. 3.	None removed.	-	-	Death - 5 days - brain injury. Bone forceps broke.
74.	Meyer.	M.	30.	May 28.94.	2. 3.	?	-	-	Death - 3 mo. brain abscess.
75.	Nicholson.	F,	62.	?	2. 3.	?	-	-	Death - 4 days - exhaustion. Haemorrhage 'terrific

LATERAL EXTRADURAL OPERATION.

Case	Surgeon's name	Sex.	Age.	Date of op:	Div:afftd.	Treatment of nerves & ganglion.	Result as to pain.	When observed.	Remarks.
76.	Richardson.	F.	58.	Aug. 9.95.	1. 2. 3.	2 & 3 & gan: removed.	No pain.	9 mo.	Paralysis of 3rd nerve, temporary.
77.	Chiene.	M.	78.	Dec. 2.97.	1. 2. 3.	2 & 3 removed.	do.	2 yr, 4 mo.	Aphasia temp. Paresis of 4th nerve temporary.
78.	Rose.	M.	?	?	?	Hartley-Krause method.	-	-	Death - 24 hours - shock.
79.	Salomoni.	M.	43.	Sep.22.94.	1. 2. 3.	2 & 3 exc:, gan: broken up & picked out.	No pain,	4 mo.	
80.	Stewart.	F.	44.	Dec.14.94.	1. 2. 3.	2 & 3 exc., gan: broken up.	do.	6 wk.	
81.	Stimpson.	F.		Sep.20.95.	1. 2. 3.	?	-	-	Death - soon after op: - brain compression.
82.	Roberts.	M.	76.	Nov.19.92.	2. 3.	2 & 3 removed.	Pain slight.	3 yr. 4 mo.	Aphasia, slight, temporary.
83.	Hutchinson.		57.	Oct. 1.97.	2. 3.	2 & 3 removed.	No pain.	1 yr. 1 mo.	
84.	Bland Sutton.	F,	53.	?	3.	2 & 3 & gan: (?) removed.	do.	5 wk.	
85.	Weeks.	M.	45.	Mar. - 97.	1. 2. 3.	? gan: picked out.	do.	16 days	Slight aphasia temporary,
86.	Thorn.	F.	64.	Aug.11.94.	1. 2. 3.	2 & 3 & pt: of gan: removed.	do.	4 mo.	
87.	Depage.	F.	56.	Jly.27.97.	1. 2. 3.	2 & 3 & gan: removed.	do.	8 mo.	Corneal ulcer; vision much impaired. 1st division cut at sphenoidal fissure.
88.	do.	F.	51.	Nov,25.97.	1. 2. 3.	do.	do.	3 mo.	Paralysis of nerves 3, 4 & 6, temporary.

THE OPERATION OF ROSE AND ITS MODIFICATIONS.

Case	Surgeon's name	Sex.	Age.	Date of op:	Div. afftd.	Treatment of nerves & ganglion.	Result as to pain.	When observed.	Remarks.
1.	Rose.	F.	60.	Apl. 2.90.	2. 3.	2 & 3 exc:, gan: picked out.	No pain.	10 mo.	Corneal ulcer; eye lost. Movement of jaw limited. N.B. Sup. maxilla removed.
2.	do.	F.	63.	Jan.29.91.	2. 3.	do.	do.	1 yr.	
3.	do.	F.	63.	Oct.29.91.	2. 3.	2 & 3 & pt: of gan: removed.	do.	9 mo.	Complaint of inability to open the mouth.
4.	do.	F.	37.	Nov. 5.91.	2. 3.	2 & 3 & gan: removed.	Pain slight.	7 mo.	Corneal ulcer; healed; vision impaired. Eust: tube injured.
5.	do.	F.	37.	Jan.16.92.	2. 3.	2 & 3 & pt. of gan: removed.	No pain.	16 days	
6.	do.	F.	69.	Feb.25.92.	1. 2. 3.	do.	-	-	Death - sepsis, 'probable wound of Eust. tube'. Dura injured with trephine.
7.	do.	F.	56.	Oct.15.92.	2. 3.	do.	No pain.	7 days.	
8.	Andrews.	F.		?	'Rt. side'	2 & 3 & gan: removed.	-	-	Death - 5 weeks - meningitis.
9.	do.	F.	62.	Early ,92.	do.	2 & 3 exc:, gan: curetted.	No pain.	5 mo.	Corneal ulcer which healed. Paresis of nerves 3, 4 & 6, temporary.
10.	do.	F.	65.	do.	?.	do.	do.	4 mo.	
11.	do.	F.	60.	do.	3.	do.	do.	3 mo.	Temporary paresis of nerves 3 & 4.
12.	do.	F.		Jan. 7.93.	'Rt.side'	do.	-	-	Death - shock.
13.							N.B. Pain	returned	in either case 9, 10 or 11.
13.	D'Antona.	F.	25.	Jan. - 91.	3.	'Rose's method' ?	No pain,	A few mo.	
14.	do.	F.		Dec.19.92.	2. 3.	2 & 3 & pt: of gan: removed.	do.	11 days,	

THE OPERATION OF ROSE AND ITS MODIFICATIONS.

Case	Surgeons name	Sex.	Age.	Date of op:	Div:afftd.	Treatment of nerves & ganglion.	Result as to pain.	When observed.	Remarks.
15.	Park.	F.	52.	Jly.11.92.	1. 2. 3.	2 & 3 exc:, gan: curetted.	No pain.	6 mo.	Grt: limitation of movement of jaw.
16.	do.	M.	62.	Oct. 8.92.	1. 2. 3.	do.	do.	10 days	Common carotid tied.
17.	Lanphear.	M.	54.	Apl. - 92.	1. 2. 3.	'Rose's method' ?	do.	13 days	Conjunctivitis (cured)
18.	Novaro.	M.	68.	- - 91.	2. 3.	2 & 3 exc:, gan: removed piecemeal.	do.	1½ mo.	
19.	O'Hara.	F.	66.	Jun.27.93.	2. 3.	'Rose's method' ?	do.	15 days	Necrosis of zygoma.
20.	Parkhill.	F.	63.	Sep. 4.92.	1. 2. 3.	2 & 3 exc:, gan: curetted.	do.	10 mo.	
21.	Rodgers.	M.	45.	May 23.93.	2. 3.	2 & 3 & gan: removed.	do.	1 mo.	
22.	Solado.	M.	34.	Oct.22.92.	1. 2. 3.	do.	-	-	Death - 9 days - sepsis.
23.	Stewart.	F.	48.	Mar.24.94.	1. 2. 3.	'Rose's method' ?	No pain.	?	
24.	Baker.	M.	52.	Jun.26.93.	1. 2. 3.	'Rose's method' ?	-	-	Death - 38 hours - shock.
25.	Caponotto.	M,	20.	Mar.18.95.	'Rt.side'	'ganglion extirpated'	-	-	Death - 4 days - sepsis. Aust: tube injured.
26.	Dandridge.	M.	45.	Mar. - 94.	1. 2. 3.	'ganglion broken up haphazard,	No pain.	10 mo.	Corneal ulcer, superficial, healed. Movement of jaw impaired.

MORTALITY 23 PER CENT.